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Chapter

Development of Supersymmetric Background/Local Gauge Field Theory of Nucleon Based on Coupling of Electromagnetism with the Nucleon's Background Space-Time Frame: The Physics beyond the Standard Model

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Abstract

A new reformulated gauge field theory comprising discrete super symmetry matrixes **U (1) = SU (2) + SO (3)** has been developed which explains why all the elementary particles appear in three families with very similar structures. The three families' performance is the product of discrete conservation of energy—momentum eigenvalue **Es = 1/2Ea** within space–time frame which appears to be the genetic code of new physics. A new supersymmetric gauge field theory of photon was developed, which describes fundamental conservation laws through invariant translation of the discrete symmetries of nature. A new gauge theory describes all the fundamental laws through isomorphism of the discrete space–time **SU (2)** frame and energy-momentum **SO (3)** symmetry group. Coupling of space and time phases of energy conservation generates the background gauge field, which in conjugation with the local gauge field mediates discrete performance of three fractional proton-neutron families of baryon structure. The presented theory requires to have a new look to our understanding of symmetry and conservation laws.

Keywords: supersymmetric theory, discrete double gauge field, discrete space–time symmetry, strong interactions, matter–antimatter symmetry

1. Introduction

From the beginning, I would like to show that there is no matter–antimatter asymmetry in nature and the matter–antimatter asymmetry would eliminate existence of our world in cyclic mode, moving to the randomness. Matter–antimatter, holding discrete supersymmetric genetic code **2Es = Ea**, appear in different phases of energy conservation with the change of frequency. The phenomenon called

symmetry breaking is the discrete supersymmetric invariant translation of background gauge symmetry to the local gauge symmetry with the invariant inverse.

Nature does not distinguish a difference between the laws, describing different scale events, and selects very simple principle, which holds symmetry with the perfect conservation laws. The main problem of classic, relativistic, and quantum mechanics theories is the application of mathematical models, which describe a break of *continuous symmetry*, *associated with the continuous energy conservation*. Due to the consumption of energy in dynamical processes with the discrete energy portions, application of continuous functions, such as Lagrangian and Hamiltonian, for differentiation of change leads to the runaway of the energy solutions to infinity. Artificial renormalization of Lagrangian/Hamiltonian dynamical equations leads to the approximate symmetry; therefore we cannot use these linear differential equations to get correct fundamental laws of nature. Due to these problems, some authors, for example, Weinberg, suggest [1] that nature is approximately simple and Yang-Mill symmetry naturally should produce approximate symmetry. Weinberg sand Glashow suggested that [1, 2] nuclear interactions have spontaneous symmetry breaking that is why these interactions may produce only approximate symmetry.

The theories, describing spontaneous breaking of continuous symmetry, with application of renormalization approach, do not provide proper mathematics of energy conservation, associated with the symmetry. Presently there is no theory, which may describe conservation of action during "change" of an event at small space and time intervals. An action is the product of energy consumption, and due to the discrete consumption of energy, the outcome product of an action has to produce discrete action formulation. However, Lagrangian continuous action principle (Hamiltonian as well) does not hold this requirement.

Our opinion is that the fundamental laws of nature cannot appear in differential formulations in correct way, if these equations do not include dynamical superposition origin and describe interactions through change of continuous function. Without involvement of the original position to the differential equation and using the continuous function, we cannot conserve energy at the origin and remove renormalization groups, adding to the physical theories.

Feynman showed [3] that you could describe an event in the Hamiltonian in the form of differential equation, which describes how the function changes in term of operator. We may provide our comment that such a task is not realizable with the Hamiltonian, because it is a continuous function and does not involve dynamical initial position. The action is the discrete space–time function; therefore, the continuous outcome of a discrete action without relation to dynamic local position is uncertain.

Feynman [4] applied renormalized Lagrangian action to quantum mechanics but even in Feynman's renormalized Lagrangian action is not conserved. The main problem of Lagrangian action and Feynman approach is the application of linear continuous action-response relation.

Therefore, we need an entirely new theory to describe reversible fundamental laws of nature, combining discrete conservation of energy with the boundary-mapped space–time, which would combine all kind of fields and forces within discrete background symmetry. Application of discrete energy conservation law and discrete symmetry as the product of this law may change drastically our present knowledge on the nature of forces and their roles in fundamental interactions. It is possible that nature and performance of forces, merging at the background symmetry, will be different, and reversibility of dynamical laws at discrete symmetry may change completely the role and classification of forces.

In our previous studies [5–7], we showed that wrong description of dynamical laws through simple continuous displacement in space–time structure using only

intervals and linearity in differential equations might be the reason for appearance of uncertainty problems of quantum mechanics and infinity in classic physics formulations. Similarly Nobel Laureate Hoof't showed [8] that "when we send distances and time intervals to zero we do assume that the philosophy of differential equations works."

In the present paper, we will discuss a new reformulated gauge theory, combining "twin brothers" of background/local gauge fields, conjugated with the new energy-momentum rotational symmetry group and associated with the discrete space–time symmetry. We will describe fundamental change of physical laws when we shift from the theories based on continuous energy conservation law to the discrete energy-momentum invariant translation, carried within the discrete space–time frame. Simply, we will present an invariant action-response exchange parity, relative to the response, which drastically changes features of classic, relativistic, and quantum theories. *The paper will describe why all the elementary particles come in three families with very similar structure. The three families' performance is the product of energy conservation within energy-momentum exchange interaction, which became the genetic code of our existence and new physics. We believe that our theory of supersymmetry is the rebirth of gauge field theory, which does not need application of renormalization.*

2. The genetic code of origin as the superposition

2.1 The illness of linear differential equations for description of energy conservation

First, I would like to discuss shortly literature information [9] to show that Newton's traditional differential equations, describing change of an event in abstract space and time, do not provide exact solution. It describes change of an event in abstract time by a smooth continuous vector field, which has local diffeomorphism, preserving only limited property of an event. Diffeomorphism is a function in smooth manifold, which describes differentiation where the original position is lost. The present mathematical knowledge does not provide any solution on how to eliminate the diffeomorphism problem of differentiation to save the initial property of a function. That is why all theories, describing symmetry, have to use renormalization, which drives them, similar to quantum uncertainty, to the local approximate symmetry.

Presently there is no mathematical solution on how to get nonlinear differential equation, which may describe change of dynamical local position from point to point on the discrete space–time, where space and time may change their dimensions relative to the energy-momentum flux to the space–time frame. This approach is very useful for a wide class of mathematical problems because it solves boundary value problems (which is in reality initial value problems) of differential equations.

Traditional differentiation describes change of interval of one variable in relation to other, for example, change of space in relation of time—**dS/dt.** We suggest a new mathematical theory for differentiation of a function without loss of the origin/local dynamical structure within multiple variables, such as space, time, and energy. Presentation of differentiation through coupling of intervals of change of multiple variables with their superposition origin produces deterministic outcome regardless of scale of interactions.

The theory, which we suggest, comprises the principle that any interaction, to hold symmetry, after change in the space–time frame, should look the same as its

background superposition/dynamical local origin of energy-momentum content and space–time frame. The basic statement of such a concept is very simple: "particles may hold their "non-charged" state of rest only in discrete mode." Such an approach is the modification of Aristotle's concept [10] that "natural state of a body to be at rest" which does not present rest in discrete mode, therefore does not hold conservation of energy.

The nature of rest is well described by Nobel Laureate Anderson [11]. By Anderson opinion, a system at stationary state of rest could not stay long and stationary state can be only equal superposition and its inverse. By his opinion, only superposition and inverse mixture may describe the absence of dipole moment. Unfortunately, Anderson did not put his statement into mathematical formulation. However, Anderson's "equal mixture" is equivalent to the equal numbers of matter–antimatter, which, as we will show later, needs modification.

We found out that we could solve the gap in "Anderson's equal mixtures "and describe stable steady-state performance of matter if we will apply vector type of discrete exchange interactions between two symmetric states, which can bring the system to superposition in discrete mode and hold discrete CP invariance of strong interactions. The superposition displays the genetic particle, while displacement from the superposition appears as the antiparticle of the superposition. It is easy to show that the origin of this principle is the conjugation of discrete conservation of energy with the discrete space–time, which is in hold for any fields/particles regardless of scale and completeness.

2.2 The basic statement of symmetry

While symmetries are conjugated with the corresponding conservation laws, we will start our analysis from principles of energy conservation. Distribution of energy in a medium requires certain space locality and time duration. The portion of energy, consumed for displacement of space, appears as the potential ingredient, while the time portion of the total energy presents kinetic energy. We may present the potential and kinetic ingredients of energy in the form of conjugated space and time portions. The suggested approach is different from Lagrangian or Hamiltonian, because these functions present continuous conservation of certain abstract amounts.

The Lagrangian or Hamiltonian functions, as Feynman stated [12], describe an abstract mathematical principle, which involves a certain numerical quantity, which has to be conserved. These formulations present some abstract number, which does not change, and after the change, we should have the same number.

Due to the conjugation with the conservation of energy, an event symmetry after the change should look the same. Therefore, a mathematical formulation of symmetry should show that (a) we have the same number of energy after change of an event and (b) an event looks the same as origin. We will describe how we can get such a mathematical formulation.

The exchange interaction of superposition (initial neutral state) with its displacement may produce two outcomes: (a) the symmetry of particles is continuous, such as the outcome of change looks the same as origin continuously, but breaks down spontaneously; (b) the outcome of change looks the same in discrete mode, with invariant translation without violation of symmetry. Later we will show that the outcome of interactions after change may look the same if the fundamental laws describe conservation of energy only in discrete mode.

Mathematically this statement, in general, may have the following form:

$$\mathbf{F}'(\mathbf{s},\mathbf{t}) = \mathbf{F}(\mathbf{s},\mathbf{t}) \tag{1}$$

Eq. (1) after differentiation may display Maxwell equations in an alternative way. If a system after change looks the same in discrete mode in opposite phase, the equation of symmetry has a negative phase solution:

$$\mathbf{F}'(\mathbf{s},\mathbf{t}) = -\mathbf{F}(\mathbf{s},\mathbf{t}) \tag{2}$$

The positive and negative solutions of dynamic supersymmetry outcomes of a discrete event together will have a form:

$$\mathrm{F}'(\mathrm{s},\mathrm{t}) = \pm\mathrm{F}(\mathrm{s},\mathrm{t}) \tag{3}$$

We can assume that the positive solution of Eq. (3) presents the discrete symmetric function in space–time phase in the local gauge field, while the negative sign is an antisymmetric solution of the symmetric function of an event in an opposite energetic phase of the background gauge field. The positive and negative solutions of Eq. (3) appear as a discrete change of the symmetric function from one phase to another phase, which is a shift of energy conservation from space–time phase (holding by ordinary matter) to the energy phase. These phases as background/local gauge fields discretely transform to each other, leading conservation of energy and symmetry in discrete mode within opposite energy and space–time phases.

The classic physics Eq. (3) in some sense is similar with Schrödinger's wave function:

$$\frac{\mathbf{d}}{\mathbf{dt}}\boldsymbol{\psi} = -\mathbf{iH}\boldsymbol{\psi} \tag{4}$$

The problem of Schrödinger's Eq. (4) is that it describes change of wave function only in one phase, which is time. The space phase representative is Hilbert space, which presents the original function but does not undergo any changes.

If classic physics could describe the symmetry and energy conservation law within the space–time frame with conjugation of space and time intervals with the dynamic local states of variables, there will be no need of application of Schrodinger's wave function (4), which uses probability approach. The wave function of quantum mechanics with the local states of space and time coordinates could have deterministic classic equation to describe the exact symmetry of Nature. The deterministic equation of background space–time symmetry after the change of an event in discrete mode may look the same:

$$\frac{\mathbf{dS}}{\mathbf{dt}} = \pm\frac{\boldsymbol{S1}}{\mathbf{t1}} \tag{5}$$

where the left side of the equation describes uniform change of space and time coordinates of an event, while the right side presents the original local space–time frame. The positive sign describes outcome of the ordinary matter phase, while the negative sign shows the outcome of antimatter. The statements of Eqs. (1)–(3) and (5), without Dirac's relativistic quantum mechanics, naturally predict existence of antiparticles to hold discrete conservation of energy within different states.

3. Development of a new mathematical theory for differentiation of change

Hoof't showed [8] that it is possible to eliminate the bad effect of small time intervals and small displacement in space by improvement of mathematical

formulation of small-scale transformation, for example, by renormalization group. However, renormalization tool leads to the approximate symmetry and renormalized artificial outcome of a natural event. The other way, which he suggested, is to find a new, improved theory.

To find new theories, we need to eliminate two problems: nonindependence feature of uncertain space displacement and time intervals in combined space–time unit and linearity of the change. We cannot get any help from special relativity (SR) and Minkowski's space–time to eliminate independent features of space and time intervals because they do not involve local origin and connect opposite time interval with the three space intervals into a nonsymmetric four-momentum frame (3:1), which involves abstract intervals of neutral space and time variables without their local positions.

We cannot use principles of general relativity (GR) theory as well because general relativity does not provide boundary-mapped reversible dynamical law due to its continuous space–time frame. GR does not have a background, which is the reason that GR's geometric, continuous space–time structure at small-scale interactions cannot find origin and runs away to the infinity. Wheeler's suggestion [13] on "space tells mass how to move, mass tells to space-time how to curve" does not produce a complete concept in a sense that it produces uncertainty because GR's space–time cannot tell to mass the path and boundary to move and mass cannot tell space–time boundary where to stop.

First, we will look how the features of dynamics change if we gradually reduce time interval $\mathbf{\Delta t}$, moving from the high scale to the small-scale event, as was done by Hoof't [8]. However, we will analyze not an interval as Hoof't did, but a function $\mathbf{\Delta f/f_1}$, which as a mathematical operator may give information about change of a function in relation to its dynamical local origin. This function is a sufficient entity for the identification of change. The non-unitary function $\mathbf{\Delta f/f_1}$ shows quantum behavior and with the fractional feature (portion) produces the outcomes with the integer numbers $\mathbf{(f_2/f_1–1)}$. The mathematical operator in the form of $\mathbf{\Delta f/f_1}$ portion describes the fraction of the change in relation to its dynamical origin. Similarly, the operator $\Delta\mathbf{S/S_1}$ describes displacement of space with the applied force in relation to its origin, while the operator $\Delta\mathbf{t/t_1}$ describes the fluctuation of time about instant of action. The functions $\Delta\mathbf{S/S_1}$ and $\Delta\mathbf{t/t_1}$ describe the entanglement of the displacement with the initial superposition as the genetic code of the event. The relation of change around its origin $\mathbf{\Delta s/S_1}$ generates a spherical space, while relation of time interval to instant of time produces a round time structure. Therefore, there is no preferred inertial system and mathematical model, which may display an event better than its initial superposition state.

In planet-scale events, reduction of the distance twice, as was shown by Hoof't [8], does not affect significantly the linearity of change. The parameter $\Delta\mathbf{S/S_1}$ also describes a similar effect of the change to the linearity. However, if we reduce interval of time twice in a small-scale event, using $\Delta\mathbf{t/t_1}$ function, we will be able to describe catastrophic effect of the change to the linearity of the motion.

The relation of intervals of time and displacement to the origin creates entanglement of the final and initial states of coordinates. The origin of an event in this case "tells the body how to move and the final state of a motion gets the information where to stop." However, the entanglement of interval of change with the origin leads to the deterministic nature of the dynamical event within a certain boundary, and it is the only way for elimination of the infinity problem of small-scale interactions. The effect of initial/local coordinate of time and space of a body appears as an action of initial energy contents (such as inertial mass, inertial energy) of a body to the change of pathway. Presently all the physical laws use only independent intervals to describe the change of an event without relation of change to the initial local

state. This is the main problem of physical laws, applying the renormalization group to remove uncertainty of initial position.

4. Energy-momentum: (a) charged antiparticle-particle pair and (b) neutral twin particles

Lagrange and Hamilton suggested conservation of energy in the form of linear differential equations as well. The main concern of these equations is that the position coordinates and velocity components are independent variables and derivatives of the Lagrangian with respect to the variables taken separately.

The specific feature of our approach is that energy, distributed within space and time portions, appears in the form of non-separable energy-momentum exchange entities. Energy in one phase appears as the consumed charged part in the space–time frame and in another phase appears as itself, comprising color ingredients of neutral photon-antiphoton pair. On this basis, we may present energy and momentum in two forms: (a) energy-momentum exists in the form of electrically charged matter–antimatter pairs, and (b) energy-momentum exists in the form of color charge pairs, where every part is an own particle of the other part. The condition of energy and momentum in forms (a) and (b) are completely different. However, the color charged bosonic pairs, which appear as "the neutral twin brothers" in the form of Majorana particles, are the superposition where it has a trend to move. In space–time phase, energy appears as Dirac's particles. It seems obvious that, at superposition of color charge "neutral twin brothers," all the ingredients of energy-momentum, as internal products, will exist in the form of twin particles.

Now we may apply this mathematical tool for characterization of any type of change, particularly ingredients of space–time. The parameters $\Delta\mathbf{S}/\mathbf{S}_1$ and $\Delta\mathbf{t}/\mathbf{t}_1$ have no unity and are unit-less parameters, which makes easy to compare them as the equivalent entities. Using Wheeler's [13] statement that the equation of special relativity $\mathbf{E} = \mathbf{mc}^2$ allows to transfer space and time equivalently to each other, we may show problems of such a statement. For this purpose, we may analyze the relationship between energy and mass portions without application of Lorentz transformations.

$$\gamma = \frac{\Delta \mathbf{E}}{\mathbf{E1}} : \frac{\boldsymbol{\Delta m}}{\mathbf{m_1}} = \frac{\Delta \mathbf{E}}{\boldsymbol{\Delta} \mathbf{m}} \cdot \frac{\boldsymbol{m1}}{\boldsymbol{E1}}; \frac{\mathbf{E1}}{\mathbf{m1}} = \boldsymbol{c2}, \Delta \mathrm{E} = \gamma \Delta \mathrm{m} \boldsymbol{c2} \tag{6}$$

Eq. (6) describes change of energy-mass equivalence with the effect of initial condition (we may call rest mass and rest energy) in the form of "non-Lorentz transformation." By literature information [14], the exact value of Lorentz factor at velocity close to speed of light is **2.00**. If we use numeral value $\boldsymbol{\gamma} = \mathbf{2.00}$, as an exact Lorentz factor [14], at uniform speed of light $\mathbf{c}^2 = \mathbf{1}$, Eq. (6) produces condition.

$$\Delta \mathrm{m} = \mathbf{1}/\mathbf{2}\boldsymbol{\Delta}\mathbf{E} \tag{7}$$

for energy mass invariant translation. The energy and mass invariance (7) appears as the product of discrete exchange of energy-momentum relation and produces half-integer-integer spin interactions of mass and integer spin carrier particles.

5. Electromagnetic energy as the origin of space-time

5.1 Alternative model of space-time structure

Based on Planck's discrete energy radiation and empirical principle of energy conservation, we can formulate a nonempirical mathematical expression of energy.

The basic principle of energy conservation states that "Energy can only be transferred from one form to another." Transformation of energy from one form to another requires boundary within the space–time frame, carrying conservation of energy through space and time portions. While conservation laws associated with the time and space frame symmetries, we may consider that equally distributed space and time portions of energy hold simultaneous conservation of energy and momentum within symmetric frame. On this bass, the energy portions, equally distributed in space or time phases, both cover the half of the total available energy: **Es = Et = 1/2Ea.** This equation is the equivalent expression of Eq. (7). Similarly, the total energy comprises the mixture of energy portions, equally distributed within two parts of the space–time frame: 2**Es = Ea**.

Based on these simple equations, we may construct mathematical model of energy conservation, which has to combine energy-momentum conservations within the space–time frame. Conjugation of energy-momentum conservations within exchange interaction, which appears in discrete mode, generates principles of discrete symmetry. In this sense, special relativity's energy-mass relation $\mathbf{E = mc^2}$ does not hold invariant discrete energy-mass exchange relation and cannot describe discrete symmetry of energy-mass relation, localized within the discrete space–time frame.

Based on such an approach, we may present space–time as a frame, which comprises cross product of space portion as materialization of energy and cross product of time portion, which at decay of space–time returns an energy to the origin:

$$\mathrm{Es}\frac{\mathbf{dS}}{\mathbf{S_1}} - (\mathbf{Ea} - \mathbf{Es})\frac{\mathbf{dt_1}}{\mathbf{t_1}} = \mathbf{0} \tag{8}$$

The first part of Eq. (8) presents the portion of consumed energy (**Es**) in space phase with the positive sign, while the second ingredient of the equation shows the remaining energy portions within the time ingredient of total energy with the negative sign. Model (8) gives the following equations:

$$\frac{\dfrac{\mathbf{dS}}{\mathbf{S_1}}}{\dfrac{\mathbf{dt}}{\mathbf{t_1}}} = \frac{\mathbf{E_a} - \mathbf{E_s}}{\mathbf{E_s}} \tag{9}$$

$$\frac{\mathbf{dS}}{\mathbf{dt}} = \frac{\mathbf{S_1}}{\mathbf{t_1}}\left(\frac{\mathbf{E_a}}{\mathbf{E_s}} - \mathbf{1}\right) \tag{10}$$

$$\boldsymbol{\lambda} = \frac{\mathbf{E_a}}{\mathbf{E_s}} - \mathbf{1} \tag{11}$$

$$\text{at } \boldsymbol{\lambda} = \mathbf{1}, \mathbf{Es} = \mathbf{1/2Ea} \tag{12}$$

$\mathbf{S_1}$ and $\mathbf{t_1}$ are the space and time variables, corresponding to the origin/dynamic local boundary, and **Ea–Es** and **Es** are the energy portions, distributed in space and time within energy-momentum exchange interaction at conditions corresponding to the background/dynamical local boundaries of $\mathbf{S_1}$ and $\mathbf{t_1}$. The background superposition as the gauge field holds the hidden initial space and time variables, which carry invariant translation of energy and corresponding symmetry from one form of energy to another and inverse. The local dynamical gauge position is the mathematical operator, which translates energy in the form of force from the local matter phase to energy phase. The **Ea** electromagnetic energy of model (9) is the symmetry generator of local gauge field, while **Es** appears as the local momentum ingredient of energy of the background gauge field.

The right side of Eq. (9) describes energy-momentum exchange interaction, relative to the original momentum of superposition, which generates shift of energy conservation from the space–time frame to the original energy phase. *The particle of space–time moves through the electric field, and electric field in reverse order propagates through the space–time field of matter.* Eq. (10) describes the cross product wave function where the local space–time wave $\mathbf{S_1/t_1}$ is carried by the flux of energy-momentum wave (**Ea/Es-1**) which changes wavelength and wave amplitude of space–time by S_1 and t_1. Conservation of energy-momentum is associated with the symmetry in time and space; therefore symmetry has to be the cross product of space–time and energy-momentum relation.

Model (10) has two important features on coupling of particle with the field. The eigenvector of model (9) connects force, field, and particle together: (a) the mathematical operator describes change of symmetry generating electromagnetic field in relation to initial momentum of a particle, and (b) it presents change of space–time position of a "non-Aristotelian" particle in relation to the symmetry-generating field.

The superposition's genetic code in the form of dynamical space–time ($\mathbf{S_1/t_1}$) unit has discrete coupling with the electromagnetic field (10). Model (10) in general form describes relation of energy portions, distributed within space–time field, which generates discrete vector space as a product of discrete energy-momentum relation. The suggested approach is different from Sudarshan and Marshak's **V-A** theory of weak force [15], while without discrete eigenfunction, producing integer spin particles you cannot reverse a particle to the background gauge field. However, Hilbert space of quantum mechanics and **V-A** theory do not carry such a performance. *The other feature of Eq. (9) is reciprocal isomorphic discrete symmetry of space–time and energy-momentum exchange interaction, which became the outcome products of each other, forming the supersymmetric gauge equation.* Such an approach allows combining all the conservation laws within these symmetric interactions.

The background gauge field's force carrier **Ea** holds the symmetry of **Es** matter ingredients of eigenfunction **(Ea − Es)/Es** in the space–time frame of local gauge field. When the symmetry generator is turned off (**Ea = 0**), the **Es** through coupling of local and background particles return to the background gauge field in the form of neutral pairs of gauge field. Based on model (10), which combines space–time with the electromagnetism (energy-momentum conservation), the origin of space–time appears to be the background gauge field energy, which generates the basic unit of matter space–time frame and holds its conservation within conjugation of background/local gauge phases.

We found out that simplifying strong interactions to the linear exchange of photons or meson within continuous symmetry is the reason for appearance of problems of particle physics theories. Particularly, Yukawa's meson theory of strong interactions, describing linear exchange of mesons, and **V-A** theory of CP violation are examples of such theories.

5.2 The space and time particles of the space-time frame

Model (9) has a philosophical meaning: we do not present time as itself, which as an entity is different from space. We present a certain entity in time phase and this entity is the energy. That is why time has no independent existence from space energy portions and is not an abstract parameter, which may flow independently. The same philosophy is relative to the space as well. We did not present an event in abstract three-dimensional space or within four-momentum frame of SR; we describe the vector space, which changes dimension and direction in accordance with the flux of energy and momentum to this space. Such a space of space–time

may change from three-dimensional frame to two- or round dimensional space–time. Based on the frequency of energy-momentum flux, space–time at the small scale moves to the round dimension, which is not possible by Hamiltonian's or Lagrangian's only time-dependent linear equations.

Replacement of intervals by combination of the origin with the displacement in the form of portions is the new algebraic expression of dimension, which as the mathematical operation carries *natural renormalization* of the change to the initial origin. Relation of the change to the initial origin generates $\mathbf{S_2/S_1–1}$ quantum operator, producing outcomes by the integer numbers.

Based on such a phenomenon, any particle of space–time field or antiparticle of energy field has no independent existence. The condition $\mathbf{E_a > 0}$ is the displacement from the superposition (field excitation) with the generation of three-dimensional space, which produces a local field and its particle (electrically charged mass). When an energy flux to space–time discontinued ($\mathbf{E_a = 0}$), the distinction between field and particle disappears, and the superposition and field merge. At $\mathbf{E_a = 0}$, the negative energy matrix produces **U (1)** symmetry group of gauge field, similar to Maxwell's theory of electromagnetism. Model (9) can be applied for any interaction of **(Ea − Es)** as a field and **Es** as a particle.

The other specific feature of our theory is that the relation of the change to its origin generates an original code as its own reference frame of an event. The state of origin of the space or time particle became their own antiparticle. When a particle does not change ($\mathbf{E_a = 0}$), its position in space, merging with its antiparticle, generates neutral particle of discrete rest. Conjugation and merging of two states (fields) became the main principle of discrete symmetry and conservation of energy within a certain boundary.

Our theory uses the background gauge field as the only possible reference frame, where all the interactions take their origin. The relation of an event or the particle's space–time frame to the background gauge field became the obvious concept, while the background gauge field is the source of interactions and mediates the space–time frame of a particle within the local gauge field. The background state is the source of symmetry generating electromagnetic force-gravitation exchange interaction in the local gauge field, which has to deliver energy back to its origin. *Gravitation appears as the short-range force, which holds discrete performance of electromagnetic force and generates stable existence of a nucleon in discrete mode.*

The inertial frame of reference in classic physics and special relativity is the same and states "the body with net zero force does not accelerate and such a body is at rest or moves at a constant velocity." Based on our theory, this statement is not completely true. When the net force flux to the space–time frame is zero **(Ea = 0)**, particles move to the reference background gauge field which holds discrete performance but not constant rest. We explain SR's time delay statement differently. By SR, "the clock of a moving body will tick slower than clock that is in rest in his inertial frame of reference." SR states that if the particle's speed approaches the speed of light, the massless particles that travel with speed of light is unaffected by passage of time.

First, the massless particles cannot have free travel due to the requirement of energy conservation within boundary. Based on model (10), time instant $\mathbf{t_1}$ is proportional to eigenvalue (12), and with the reduction of this value, the time instant and clock will tick slower than the background state.

The relation of change to initial origin eliminates unity which allows describing energy portions in space and time phases within any symmetric dimensions which may change from linearity of planet-scale event (string like dimension) to round dimension of baryon-scale interactions. The minimum portion of quanta, produced from the nonlinear energy-momentum exchange vector interaction, generates an

elementary space–time frame. The condition **Es = 1/2Ea** of model (10) generates the invariant translations in a space–time frame:

$$\frac{\mathbf{dS}}{\mathbf{S_1}} - \frac{\mathbf{dt}}{\mathbf{t_1}} = \mathbf{0} \tag{13}$$

When symmetry generator electromagnetic energy is turned off (**Ea = 0**), we will get decay of space–time and shift of energy from local gauge space–time frame to the energy phase of the background gauge field:

$$\frac{\mathbf{dS}}{\mathbf{S_1}} + \frac{\mathbf{dt}}{\mathbf{t_1}} = \mathbf{0} \tag{14}$$

Eqs. (13) and (14) are the alternative presentations of Eq. (5). The portions of energy, carried by space and time identities $\mathbf{dS/S_1}$ and $\mathbf{dt/t_1}$, play a role of the quantum operator of annihilation or creation, through coupling with the energy-momentum exchange interactions.

The condition **Es = 1/2Ea** became the energy-momentum genetic code of particle-antiparticle interactions in the discrete space–time frame. The genetic code of Eq. (13) in the space–time frame generates a three-jet performance of ingredients of energy-mass exchange interaction.

The concept of supersymmetry, which we suggest in (9), describes the conjugated symmetry, which involves simultaneous symmetry of space–time frame and energy-momentum exchange interactions, carrying both in discrete mode.

5.3 The theory of spin as the product of discrete energy-momentum exchange interaction

In accordance with our concept, a change of particle's displacement around their superposition generates the conserved quantity called spin, which in quantum physics has identification, as the angular momentum. By quantum physics, the spin number for a point particle is the product of pseudo-vector position (relative to some unknown origin) and its momentum vector $\mathbf{r} \times \mathbf{p}$ [16].

In accordance with our theory, the spin is the conserved vector quantity, produced from conservation of energy within discrete energy-momentum exchange relation, which generates for ingredients of this interaction's spin numbers (12). The space and time portions of energy in exchange interaction (12) appear as interaction of fields, which produces the ingredients of this interaction in the form of fermions and bosons.

The quantum physics' presentation of spin, as a cross product of vector position with the momentum, does not produce quantity, which may carry energy-momentum conservation in a proper way. The quantum mechanic's specification of spin is a very abstract concept because the point particle is not a particle, which does not have a space–time frame of matter and therefore cannot produce half spin identity in the form of fermion. We suggest the identification of angular momentum as a product of the particle's space–time position vector and energy-momentum exchange interaction (10), which produces not the pseudo-vector but the local space vector. This vector generates a deterministic pathway of a particle's dynamics. In such a model, the dynamic local position became the deterministic position vector. Therefore, we may identify fermions and bosons only as the products of space–time frame. Due to these features, quantum mechanics cannot explain unusual feature of baryon frame where two identical quarks in proton or neutron frame do not obey the Pauli rules of quantum statistics.

The genetic code of supersymmetry **Es = 1/2Ea** explains this paradox. The antisymmetric wave function (13) holds the invariance of baryon performance through discrete symmetry, carried within background and local gauge fields. From supersymmetric genetic code.

Es = 1/2Ea (12) follows why quark ingredients should have **2/3** and **1/3** fractional charges. From three portions of energy (charges), only two portions describe one type of charge, and the other one portion describes another charge, holding the requirement of discrete **Es = 1/2Ea** symmetry.

6. The invariant translations within fermion-boson pairs

By Wilczek's [17] opinion of getting symmetry and maintaining the balance of conserved quantum numbers, the extra particles should exist by an equal number of antiparticles. However, our theory predicts that invariant translation of ingredients of energy-momentum exchange interaction should not involve equal numbers of particle-antiparticle pairs but has to follow the condition of Eq. (12) **Es = 1/2Ea**. We think that the concept of equal numbers appeared from wrong identification of a particle as a point-like particle, which cannot produce identity for fermion. In accordance with the invariant translation (12), from one charged fermion, we can produce only half-neutral boson. Therefore, based on invariant particle-antiparticle translation (12), to get a neutral bosonic particle, we have to double the number of particles to produce a neutral boson:

$$\mathbf{2}\,(\mathbf{Es} = \mathbf{1}/\mathbf{2Ea}) \rightarrow (\mathbf{2Es^t} = \mathbf{Ea^t}) \tag{15}$$

This operation is similar to quantum mechanic's doubling of wave function. However, in our case it is due to combining of energy portions, distributed in space and time phases to get full portion of energy at the origin in the form of boson. Elimination of dipole moment requires removal of charges in the space–time frame of matter, which requires decay of the space–time frame of ordinary matter and restoration of energy at the origin. However, the fractional charges of nucleons of baryon structure do not allow separation of quarks with elimination of charges. To eliminate this restriction, virtual particles with the fractional charges of baryon structure undergo coupling to pion families, which, as intermediate bosons, carry easy decay with production of neutral particles of the background gauge field.

The π-mesons generation through coupling of proton-antiproton or quark-antiquark pairs during decay of space–time frame was proven by experiments, carried out in Berkeley Center where it was observed that formation of neutral field, which could be accounted for neutral π-mesons, created by collisions of high-energy protons. In addition, it was shown that the neutral mesons decayed into two mesons with the lifetime of the order of $\mathbf{10^{-13}}$ **s** or less [18].

The produced π-mesons family became intermediate spin zero bosons due to the decay of the space–time frame of matter, while the spin number is the product of energy-momentum exchange interaction within the space–time frame of ordinary matter. On this basis, the coupling particles get the performance of the neutral particles of gauge field. The doubling of particles (14) at **Ea = 0** reverses the performance of the forces due to the transition of energy conservation from space–time phase to energy phase with the change of sign (13).

The shift of symmetry from space–time frame local field to the background gauge field symmetry leads to the disappearance of spin and generation of gauge field particles due to the coupling of initial and local momentum in the form **(−Es/Es)** of Eq. (10).

It is necessary to note a very important feature of translation of ingredients of Eq. (14) when the ingredients of this equation doubled. The half-integer fermions of this equation became integer carrier particles, while integer carrier particles became double integer carrier particles. Therefore, in energy phase the performance of forces holding space–time frame changes in the opposite order.

Based on model (10), depending on the energy flux to the space–time frame, the helicity of the ingredients of the space–time frame changes. In accordance with Eq. (14) when electromagnetic interactions turned off (**Ea = 0**), the difference between space and time phase particles disappears, and all the particles behave as integer number particles of the background gauge field. In this case, the chirality and handiness of particles gets the same left-handed direction. When local symmetry generator force is not available (**Ea = 0**), the momentum of matter space–time phase (10) transforms to the energy of the gauge field and gets a negative sign. Simply, "the ingredients of energy return to itself." In this case, Dirac's neutrinos transform to the neutral Majorana neutrinos having left helicity to the background gauge field where bosonic particles involve gamma rays, neutral fermions pair, and neutral neutrinos.

To understand the nature of particles and forces, we have to analyze the decay mechanism of produced pion families, where the W vector bosons were intermediate ingredients:

$$\pi^{+} \rightarrow \boldsymbol{\mu}^{+} + \boldsymbol{\nu}_{\boldsymbol{\mu}} \tag{16}$$

$$\pi^{-} \rightarrow \boldsymbol{\mu}^{-} + \boldsymbol{\nu}_{\boldsymbol{\mu}}{}^{-} \tag{17}$$

$$\pi^{0} \rightarrow 2\boldsymbol{\gamma} \tag{18}$$

The produced ingredients of the decay form the balance equation:

$$\pi^{+}\pi^{-}\pi^{0} \rightarrow 2\boldsymbol{\gamma} + \boldsymbol{\mu}^{+}/\boldsymbol{\mu}^{-} + \boldsymbol{\nu}_{\boldsymbol{\mu}}/\boldsymbol{\nu}_{\boldsymbol{\mu}}{}^{-} \tag{19}$$

The decay of the local gauge field to hold vector conservation produces a new vector, which comprises generation of intermediate W vector bosons from decay of π pions. The **2Es = Ea** code of the background gauge field requires equal numbers of electron and neutrino family pairs which is realized by the equal branching ratios of the decay of intermediate W vector bosons. Eq. (19) describes decay condition in average for muon family leptons.

The product stream composition generates composite of neutral particles, which exists in annihilation mode in the background gauge field to hold equation 2Es = Ea:

$$2\boldsymbol{\gamma} \leftrightarrow -\boldsymbol{\mu}^{+}/\boldsymbol{\mu}^{-} + \boldsymbol{\nu}_{\boldsymbol{\mu}}/\boldsymbol{\nu}_{\boldsymbol{\mu}}{}^{-} \tag{20}$$

In the discrete energy conservation mode, the particles cannot hold annihilation process for a long time. Coupling of gamma rays with the neutral particles leads to the generation of charge and electromagnetic force of local gauge field:

$$2\boldsymbol{\gamma} + \boldsymbol{\mu}^{+}/\boldsymbol{\mu}^{-} + \boldsymbol{\nu}_{\boldsymbol{\mu}/}\,\boldsymbol{\nu}_{\boldsymbol{\mu}}{}^{-} \leftrightarrow \boldsymbol{\mu}^{-}/\boldsymbol{\nu}_{\boldsymbol{\mu}}{}^{-} + \boldsymbol{\mu}^{+}/\boldsymbol{\nu}_{\boldsymbol{\mu}} + \mathbf{Ea}\,(\mathbf{electromagnetic\ force}) \tag{21}$$

The intermediate step in the symmetric translation from fermions to gauge field is the transformation of proton-antiproton pair to neutron-antineutron Majorana-type particles, which decompose to kaon family mesons. Due to the existence of three fractional proton-antiprotons, comprising other flavors of quarks, the decomposition of neutron-antineutron pair produces three kaon-type mesons. The decay products of other unidentified two kaons, which we may call $\mathbf{Kaon_2}$ and $\mathbf{Kaon_3}$, can be described similarly by Eqs. (16)–(19).

In accordance with the equation $\mathbf{E_s = 1/2E_a}$, for transformation of fermions to bosons (transformation of mass back to energy), we have to double the numbers of particles through coupling of space and time phases, carrying energy portions. In reverse order, for generation of fermions from bosons (generation of mass from energy), we have to separate space and time phases (12) to produce charge and reduce spin numbers of particles.

While our theory involves meson families as intermediate particles within half-integer-integer particle transformations, we may compare our supersymmetry theory with the basic principles of Yukawa's meson theory. The background of Yukawa's theory is the spontaneous breaking of continuous symmetry [19] and involves interaction between scalar ϕ and a Dirac field ψ. Yukawa's vector in the form of pseudo-scalar field is the linear combination of nuclear force-electric dipole moment ($\boldsymbol{\varphi - \varphi_0}$) which is very similar to V-A theory [15]. Both theories cannot describe CP invariance of strong interactions, while the linear combination of vectors could not produce translation of interactions to the initial state.

In Yukawa model, meson is the force carrier, but in accordance with our theory, meson is the product of invariant translation from baryon frame and is the intermediate ingredient of the background gauge field where all the forces merged.

7. The Yang-Mills theory and the mass gap of Yang-Mills theory

The main feature of Yang-Mill theory [1, 20] is that to produce differentiable manifold it applies continuous elements of Lie group. Yang-Mills theory, using differentiable manifold of non-Abelian Lie group and continuous Lagrangian, tried to describe the behavior of elementary particles through the combination of electromagnetic and weak forces. The non-Abelian Lie group is opposite to discrete symmetry, while traditional differentiation is not applicable for discrete symmetry group. The Yang-Mills theory does not have mathematical formulation for proper matrix reduction to get the nonzero mass particles of the local gauge field.

The Yang-Mills theory does not explain why the weak force has continuous energy spectrum. Pauli [21] suggested the production of massless neutrino together with the electron to explain continuous spectrum, but this explanation was not valid because quantum field theories have no mechanism for translation of space–time fermions to the gauge field bosons, showing continuous energy spectrum. Yang and Mill had no choice and selected the only possible way—application of non-Abelian Lie group, having Lagrangian manifold. The other problem of Yang-Mills theory is the application of energy-momentum four-vector (R^4), which leads to the V-A-type energy-momentum spectrum that produces a gap in energy between zero and some positive number.

However, the Yang-Mills theory is the only correct concept among all particle physics theories, used to describe strong interactions. The very important feature of the Yang-Mills theory is that it suggests simultaneous production of massless photons in addition to three massive bosons. Unfortunately, this excellent suggestion has no proper mathematics, which could describe invariant translation of gauge bosons to fermions of strong interactions.

8. Dirac's relativistic quantum theory and problems of Dirac's "electron sea"

Dirac [22] applied the relativistic theory to Schrodinger's equation to get relativistic wave function of electron motion. The problem of Dirac equation was negative energy solution. To solve this problem, Dirac assumed interaction of electron with

the electromagnetic field where the electron was placed in a positive-energy eigenstate to get decay into negative-energy eigenstates. However, such an approach had a problem that the real electron would disappear by emitting energy in the form of photons.

Based on our theory on discrete performance of nucleon ingredients, it is easy to show that generation of photons from fractional electron charges at coupling mode predicts existence of its antiparticle-positron. Model (9) presents electromagnetic interaction of space–time particle **(Es)**, particularly electron, with the electromagnetic field (**Ea)**, through deterministic energy-momentum exchange interaction without the application of relativistic quantum approach.

In the absence of electromagnetic field (**Es = 0)**, this interaction moves to the background energy field through merging of photon's fractional electric charges to particle-antiparticle pair **e/e** and **ν/ν** with the generation of a neutral current instead of Dirac's electron "sea."

For formulation of gauge field theory, instead of Dirac's relativistic approach, we used classic principles: (a) formulation has to hold symmetric space and time derivatives, in relation to origin, and (b) energy-momentum exchange relation has to present the momentum and energy as the space and time parts of a space–time vector instead of a four-momentum frame of Dirac's relativistic theory.

The basic principles of our supersymmetric theory replaced Dirac conditions through (a) and (b). The problem of Dirac's approach is that the space and time derivatives enter to the equation with the second order, which led to the loss of the original function and its first-order derivative. That is why Dirac's equation could not find the local position of an electron in motion in a deterministic way and used probability density. The second problem of Dirac equation is that he introduced to his equation relativistic energy-momentum relation in the form of linear space–time vector, similar to Sudarshan's V-A vector that could not produce integer spin carrier neutral particle field from half-integer spin carrying fermion particle. This was the reason for the theory to produce "electron sea." In accordance with the supersymmetric theory, fermion-showing performance as a particle in local space–time gauge phase became a field of neutral bosons of background gauge phase of energy. This is the supersymmetric feature of nature.

In gauge energy phase, electron and positron coupling to **e/e** generates, together with the Majorana **ν /ν** neutrinos, a vacuum "sea" of neutral current. Therefore, the "Dirac sea of electrons" in reality is the gauge field of neutral particles. The energy of the field is finite and has a boundary within the space–time frame, existing through discrete shift between space–time and energy phases of energy conservation.

9. Performance of Dirac's and Majorana neutrinos in model

Particle physics does not provide any information why Dirac's neutrinos have to transform to Majorana neutrinos. The exchange interaction (**Ea/Es − Es/Es)** of Eq. (10) determines the nature of neutrinos. When interaction with electromagnetic energy is off (**Ea = 0)**, the difference between **Es** in the denominator and nominator of Eq. (10) disappears. The **Es** of nominator presents local momentum, while the **Es** in the denominator describes initial momentum as genetic code of superposition. At (**Ea = 0)**, the momentum ingredients of expression **Es/Es** became equivalent and cancel each other with the disappearance of charges of quarks **(e−/ν−)/(e+/ν)** → **(e/e)/(ν/ν)** and generation of Majorana neutrinos **(ν/ν)** and neutral **e/e** fermion pairs of gauge field in the form of bosons. In the energy phase, the gauge field Majorana particles became boson particles, and the chirality and the handiness get the same direction. *Transformation of fermions of local gauge field to the*

background gauge bosons as the intermediate particles is the necessary step for invariant translations of strong interactions.

The mixture of neutral electron-positron pairs and Majorana neutrinos generates the spin 2 neutral particles of graviton of spin zero gauge field, carrying gravitation force to the background vacuum with the velocity faster than electromagnetic force in any medium. Therefore, gravitation force appears in reverse order from electromagnetic energy through coupling of entangled space and time portions of energy to restore it at the background vacuum (**Ea = 0**). It is not "spooky action at a distance" [23] but coupling of entangled non-separable portions of energy, existing in different forms.

The mass of Majorana neutrinos (Majorana mass) in the background gauge field is very low, but they became massive as Dirac neutrinos of baryon structure due to the entanglement with the charged electron family particles. Due to the decay of space–time phase at (**Ea = 0**), the particles of gauge field has the continuum spectrum. The **e/e** and **ν/ν** pars have no independent existence, but with the gamma rays, they form dark matter and energy content with ratio 33 and 66%, holding **Ea = 2Es** gauge field frame of energy conservation.

At vacuum expectation value takes place discrete shift of gauge field energy back to the local gauge field of space–time. Majorana neutrinos became again Dirac neutrinos with the generation of charge and massive particles of exchange interaction **(Ea−Es)/Es**.

10. The problems of Weyl spinors and quantum field theory

Quantum field theory suggests existence of massless half spin fermions and provides relativistic Weyl equation for description of massless half spin fermions. Due to the connection of Weyl's spinor to Dirac's theory of half spin electron, Weyl spinors describes Dirac fermions in the form of two ½ spin massless fermions. Quantum field theory does not explain physical nature of Weyl's massless spin ½ particles, while spin ½ fermions in Dirac structure are massive particles. Dirac's theory describes energy-momentum relation as a continuous function that is why physical nature of predicted massless ½ spin fermions remains open. In accordance with our theory, neutrinos, existing in pair with the electron and positron, as Dirac fermions in quark's structure, in energy phase transform to integer spin "twin" Majorana particles. In mathematics, usually such an inversion has to meet requirements of spinors.

The spinor is the mathematical operation [24], which produces vector space by addition of vectors together or multiplication by numbers, called scalar. The vector addition or scalar multiple operation must satisfy requirements, called axioms. The real vector space presents a physical quantity such as force and multiplication of a force by a real multiplier which produces another force vector.

Spinor, as a vector, exhibits inversion, when a physical system constantly rotates through a full turn (360°). In the following chapters, we will explain scalar multiplication in strong interactions and will provide mathematical framework, carrying the inversion of particles from half spin to integer spin neutral particles with the simultaneous change in the nature of existing force.

11. Development of new gauge field as the frame for discrete conservation of energy

11.1 General principles

The idea of a gauge theory appeared from Weyl spinors, but Weyl's theory, as we mentioned, could not produce the gauge scalar field due to the helicity problem

of neutrinos, and the produced particles remained spin ½ fermions. The neutrinos helicity was the main problem of all of the field theories which did not allow to describe fundamental laws of nature in a proper way. The question why nature has no right-handed neutrino produced an opinion [25] that "God decided that Nature should be left handed." Due to this problem, particle physics theories suggest that nature respects parity with regard to all the fundamental forces with the exception of the weak interaction, which involves neutrinos.

Based on our model (9), the generation of free neutrinos and antineutrinos takes place at cutoff electromagnetic interactions (**Ea = 0**), which reverses the momentum to the background state. The problem is that Weyl's theory determines the spin only relative to the positive momentum vector, and individual ½ spin carrier massless Weyl spinors violate conservation of parity. For this reason, Pauli specified Weyl spinors "unphysical" [21]. Weyl's theory could not combine neutrinos to hold parity conservation in the form pair of virtual Majorana particles.

Weyl's theory cannot explain why production of his spinors in the unitary transformations takes place only in the presence of half angle. Hamilton rotation about some axis, in a similar way, connects half angle and the Pauli matrixes. The presence of half angle in both cases was unavoidable [25].

Model (10) shows that at **Es = 1/2Ea**, the invariant translation within complex space–time coordinates are connected within tangent 45 which describes space–time symmetry $\mathbf{t_1\ \Delta S = S_1\ \Delta t}$ in the form of coordinates **y = x** symmetry. This is the half-angle mystery of Weyl and Hamilton translations. The two-dimensional space–time frame in association with the **Es = 1/2 Ea** discrete energy-momentum symmetry carries this translation.

Hamiltonian and momentum are the adjoint elements of the Lie Algebra group that generate linear transition in space and time. Model (10) presents the nonlinear energy-momentum exchange relation as the adjoint elements of three-dimensional **SO (3)** group and shows that Hamiltonian linear transformation alone cannot do invariant translation. Due to the involvement of symmetry generator force **Ea**, the translation has to be with the change of dimension. The invariant translation requires conjugation of invariant space–time frame **SU (2)** with the three-dimensional energy-mass exchange transformation through **SO (3)** group where change of space–time dimension is the driving force of translations.

Under unitary transformations, one rotation (360°) does not bring the state of a body to the origin. One rotation brings **SU (2)** x **SO (3)** local gauge symmetry to **U (1)** matrix with simultaneous transformation of a three-dimensional particle frame to linear gauge field. Therefore, full translation of opposite phases holds condition: **SU (2) x SO (3)/U (1).** Doubling the spin numbers of quark ingredients through coupling of space and time portions of energy **Es = 1/2Ea** to **2Es = Ea** produces unstable pions which produce non-charged boson-like ingredients of the background gauge field **U (1).**

The second transformation with the reversing of **U (1)** symmetry group brings the linear gauge field back to the space–time **(SU (2)** x **SO (3))** frame of three particles of baryon structure**.** Coupling of neutral **e/e**, **ν/ν**, and **p/p** ingredients in such a translation generates quarks of baryon structure. The invariance between bosons and fermions in the form of strong interactions is possible only in discrete mode with the change of space–time dimensions.

With the reversed momentum line (**Ea = 0**), the antineutrino changes its helicity and becomes the left-handed particle, which leads to the coupling of two neutrinos in the form of bosonic twin particles. The right-handed neutrino would block generation of **U (1)** field and its translation back to **SO (3)** matrix, that is why

nature does not allow its existence. Weyl's theory due to the wrong helicity misses these translations.

The other problem of quantum mechanics is that it eliminates participation of neutrinos in strong interactions due to the absence of charges. However, our theory shows that neutrinos are the necessary ingredients for generation of strong force, while coupling with the neutral **e/e** pairs generates formation of charges through their reproduced right–left helicity in **SO (3)** group.

Without conjugation of **SU (2)** and **SO (3)** symmetry groups, the description of chiral symmetry is not possible. At **Ea = 0**, Dirac particles transform to Majorana neutral massless particles which eliminates the difference between handiness and chirality.

11.2 Mathematical framework of discrete gauge field

Gauge, in common sense [26] is a measurement of a relative position of a system with reference to another abstract system to determine boundary of measurement. The gauge theory has no mathematical framework relative to the proper reference frame for measurement of change. In this aspect, the gauge theory has the same reference frame problem of classic physics.

Based on literature [26], the gauge symmetry has specification, as "is a lack of change when some field being applied." The meaning of this statement is that the measurable quantity after the change looks the same. Linearly differentiable Lagrangian of non-Abelian algebra due to the absence of the space–time frame cannot provide a mathematical formulation on how the gauge field after the change may look the same.

The theory, which we apply, provides a mathematical framework to the gauge theory to measure a quantity, relative to its initial superposition state. We suggest that change of energy and momentum in discrete mode generates the dynamical operator of gauge field, which describes the measurement in relation to the initial origin with the integer numbers of energy portions.

When the superposition of a gauge field after displacement within space, time, and energy looks the same, the invariant transformation produces invariance for all the inner ingredients of the change $\mathbf{\Delta S = S_1}$, $\mathbf{\Delta t = t_1}$, and **Ea –Es = Es** with the realization of condition **1 = 1** (9).

The genetic code of exchange interactions **Es = 1/2Ea** keeps the discrete symmetry of force carrier and electrically charged ingredients of space–time at different spin numbers (12). In the energy phase (13) of gauge field, the genetic code **Es = 1/2Ea** undergoes multiplication by scalar **2** to **Ea = 2Es** which holds the discrete symmetry within color charge ingredients of gauge field, leaving spin untouched. When the electromagnetic interactions is off (**Ea = 0**), coupling of space and time portions of energy generates transformation of half spin matter fermions to integer bosons ν/ν + **e/e** + $\mathbf{p/p}$ family of background vacuum:

$$\frac{\mathbf{dS}}{\mathbf{S_1}} = \frac{\mathbf{dt}}{\mathbf{t_1}}\left(-\frac{\mathbf{E_s}}{\mathbf{E_s}}\right) \tag{22}$$

When electromagnetic energy is off (Ea = 0), merging of space and time portions of energy generates left side helicity for all the non-charged ingredients of gauge field of background vacuum. At this condition, all the half-integer fermions merging with their own antiparticles form neutral integer spin carrying bosonic particles. Eq. (22) is the equation of vacuum, where space and time portions of energy merging generates a one-dimensional space–time frame of vacuum.

The integer spin carrying particles, produced at zero electromagnetic interactions within baryon's space–time frame, can hold invariance of gauge field only in discrete mode:

$$(\mathbf{e} - /\boldsymbol{\nu}-)/(\mathbf{e} + /\boldsymbol{\nu}) \leftrightarrow (\mathbf{e}/\mathbf{e})/(\boldsymbol{\nu}/\boldsymbol{\nu}) + \boldsymbol{\rho}/\boldsymbol{\rho} \tag{23}$$

The symmetries of space–time (**Es = 1/2Ea**) and energy (2**Es = Ea**) phases do not have independent existence and only in conjugation carry discrete conservation of energy.

We assume that **2Es = Ea** frame of the background gauge field involves a combination of elastic (Thomson effect) and inelastic scattering (Compton effect) where inelastic scattering gradually transforms to elastic scattering. At background vacuum expectation value takes place translation of the background gauge field energy to space–time frame of local gauge field by elastic scattering, which involves absorbing of gamma rays by the virtual matter bosons. This process shifts the continuous spectrum of longitudinal waves of the background field of bosons to the discrete spectrum of transference waves of charged matter particles. This is the process, which eliminates generation of ultraviolent divergences.

According to quantum mechanics, vacuum energy without renormalization mathematically is infinite. However, this statement is true only if the background's gauge field energy has no shift to the local gauge field of matter's space–time frame. During shift of the background gauge field's energy to the local space–time field, Majorana neutrinos transform to Dirac neutrinos with the transformation of color charges to the electric charges of quarks.

11.3 Mechanism of conjugation of background and local gauge fields

In accordance with our theory, if field does not change, it cannot hold energy conservation and symmetry within reversible dynamic translations. Energy can exist only through propagation in space–time frame, and in reverse order, space–time is the matter product of energy distribution. On this basis, conjugated existence of background energy and local gauge matter fields is the necessary condition for conservation of energy.

The energy-momentum exchange relation of the model (12) in the form of eigenvector generates exchange of particle with the field. The energy-momentum exchange relation of eigenvector (12) describes the relation of two fields, such as electromagnetic-gravitation fields, which carry invariant translation to each other. Electromagnetic force in the form of **Ea** can be a vector field and at the same time photon particle. At **Ea = 0**, the electromagnetic force disappears as a field/particle and transforms to gauge field of boson ingredients.

Model (10) describes local gauge field $\mathbf{S_1/t_1}$, which carries energy at each point of space–time. Local gauge field carries electromagnetic force in space–time frame in the form of energy-momentum content and strength of electromagnetic field determined by its coupling with the local space–time field. Model (10) combines all types of interactions and translates them to each other through energy-momentum exchange interaction. In this case, background/local gauge field of articles appear as the "two worlds of particles."

The vector space, as specified in mathematics, moves through plane wave, which is field. By the requirement of vector space [24], the field where the vector has to move requires existence of two equivalent field functions that determine the field value. These functions involve two parameters, which are time and displacement along the direction. In accordance with our model (13), the symmetry of energy portions, distributed evenly within space and time phases, generates two

field functions of negative displacement by the conjugation of space and time variables:

$$\mathbf{s_1\Delta t} = -\mathbf{t_1\Delta s} \tag{24}$$

Therefore, the ingredients of Eq. (13) generate two equivalent functions:

$$\mathbf{F_t}(\mathbf{s_1}, \mathbf{\Delta t}) = -\mathbf{F_s}(\mathbf{t_1}, \mathbf{\Delta s}) \tag{25}$$

The function **Fs** describes displacement in space, while the function $\mathbf{F_t}$ describes duration of change. When the values of field function are vectors, the plane wave is longitudinal. The space and time portions of energy in the background gauge field form a one-dimensional space–time frame that is why the plane wave in this case is longitudinal. Multiplication of equation **(Es = 1/2Ea)** by scalar **2** leads to the formation of neutral particles **e/e**, **ν/ν**, and **ρ/ρ** of the background gauge field **2Es = Ea** in the form of spinors, similar to Hamilton quaternions spinors [25]. The ingredients of Hamilton's equation **(I; J; K)** are imaginary quantities, while the products of our model are virtual particles:

$$\mathbf{I}^2 = \mathbf{J}^2 = \mathbf{K}^2 = \mathbf{ijk} = -\mathbf{1}\ (\mathbf{Hamilton}) \tag{26}$$

$$\mathbf{e/e} = \boldsymbol{\nu}/\boldsymbol{\nu} = \boldsymbol{\rho}/\boldsymbol{\rho} = (\mathbf{e}\boldsymbol{\nu}\boldsymbol{\rho}) = -\mathbf{1} \tag{27}$$

$$(\mathbf{Es} = \mathbf{1}/\mathbf{2Ea})\ (\mathbf{Space–time\ phase}) \rightarrow \mathbf{Inversion\ to\ energy\ phase}\ (\mathbf{2\,Es} = \mathbf{Ea}) \tag{28}$$

The equation **(2Es = Ea)** produces a new vector where the scalar is the real number. The inversion transforms integer spin electromagnetic force to the other force being integer **2** spin carrying force. The new force is the gravitation, which with continuous longitudinal wave moves to the background through conjugation of ingredient **(eνρ)** of produced neutral spinors.

It is necessary to note that generation of inversion vector space for transformation of energy conservation from space–time phase to energy phase meets all the requirements, required for scalar multiplication procedure, given in the form of axioms [24]. One of the requirements of axioms is the condition **x + (−x) = 0**, which is in hold within discrete annihilation of space and time variables (14). Due to the conservation of energy within discrete energy and space–time phases, an event comes to the origin after two full rotations (720°). The generated field has an algebra of zero-dimensional geometric spinor with one-directional helicity to the background origin.

Model (9) describes conservation of energy through non-unitary space–time variables, which unifies fields, particles, and forces within non-unitary energy portions allowing transformation of all the identities to each other. The background plasma-like gauge field can hold the discrete symmetry only through coupling with the local gauge field. The local gauge field of virtual matter, which is the combination of electric and magnetic fields, holds interaction of electrically charged space and handiness carrying time particles within the discrete space–time frame. The driving force for generation of local gauge field's space–time frame of matter is the discrete conservation of energy-momentum pairs.

Due to the absence of space–time frame, the neutral particles of the background gauge field have only color interactions with the feature of "neutral crystals" of time and space portions, bubbling in gauge field condensate with the small wavelength. Recently Wilczek [27] described the similar idea in more details.

11.4 Invariant translation of symmetries within background/local gauge fields

Background gauge/local gauge fields exist in the form of field-anti-field pair. Due to the energy-momentum non-commutation, the local gauge field is the non-Abelian, while background gauge is Abelian field. Generation of non-Abelian local gauge field from background Abelian's gauge field is not spontaneously symmetry breaking. The local gauge field at **Ea = 0** of model (9) merges with the background gauge field, as particle-antiparticle pair. In this case, the difference between particle and field disappears. The background and local gauge fields are connected through **SO (3)** rotational matrix which carries invariant translation of particle to field. Quantum mechanics mediates physical quantity by the square of the wave function, but **SO (3)** group of model (9) mediates physical quantity of the background gauge field by coupling of space–time portions of energy, carried in the form of matter–antimatter pair.

Model (9) suggests that CP symmetry of strong interactions is in hold only through cross product of **SU (2) x SO (3)** symmetry groups within two transformations: one is charge cancelation translation, and the second is parity transformation.

Yang-Mills [24, 28] attempted to apply gauge theory to the strong interactions through elevating of global symmetry to local gauge symmetry, but this attempt produced symmetry breaking. Without conjugation of **SU (2)** matrix of space–time frame and energy-momentum exchange interactions **SO (3)** (9), the background gauge field **U (1**) cannot carry invariant translation of mass to the opposite phase of local gauge field of strong interactions.

By Glashow's opinion [2] electromagnetism is mediated not only by photons; it arises from the requirement of local gauge invariance. However, based on our theory, this statement is true only partly because the role of local gauge field is reversible and symmetric. The local gauge field is needed for generation of electromagnetic interaction and cancelation it takes place by gravitation for discrete conservation of energy within space–time of baryon frame. The **SO (3)** symmetry group of gauge field translates electromagnetic force to the gravitation force. Therefore, without gravitation force, it is impossible to get invariant performance of strong interactions. The Standard Model, as Kibble showed [29], did not find place for gravity, and that is why it cannot not explain why the elementary particles come in three families with very similar structure but wildly differing masses.

In our theory electromagnetism and gravitation are unified within **SU (2) x SO (3)** symmetry of local gauge field which involves unification of charges as the internal products of baryon's space–time frame. The genetic code of baryon particles **Es = 1/2 Ea** holds all the internal conservation laws: baryon conservation, isospin conservation, hypercharge conservation, and boson-fermion spin invariant translation. It is known that the hypercharge of **SU (3)** symmetry is one of two quantum numbers of the hadrons and alongside with isospin I_3 follows the formula: $\mathbf{Q = J_3 + 1/2Y}$. For multiples of particles, the hypercharge gets formulation **J = 2Q.**

According to model (9), at local gauge field, the hypercharge current coupling is the condition **Es = 1/2 Ea** which describes local space–time symmetry at $\mathbf{J_3 = 0}$. At the background gauge field, the hypercharge conservation **Ea = 2Es** describes multiple bosons, similar to **J = 2Q.** Based on Eqs. (8)–(12), the discrete conservation of energy at the background gauge field produces condition:

$$\Delta F = \frac{\mathbf{\Delta S}}{\boldsymbol{\Delta t}} + \frac{\mathbf{S1}}{\mathbf{t_1}}; \frac{\mathbf{\Delta S}}{\boldsymbol{\Delta t}} = -\frac{\mathbf{S1}}{\mathbf{t_1}}, \Delta F = \mathbf{0} \tag{29}$$

The equation **ΔF = 0** describes discrete nonvanishing energy state of spin zero boson's condensate of the background gauge field.

12. Principles of isomorphism of SU (2) and SO (3) symmetry groups

We developed a new algebra for the isomorphism of **SU (2)** matrix to **SO (3)** group which holds 3D rotation about three-dimensional R^3 Euclidean space, to preserve the origin in discrete mode. The **SO (3)** three-dimensional matrix describes the three-jet performance of elementary particles.

The left side of model (9) is **SU (2)** matrix of space–time, but the right side describes three-dimensional energy-momentum exchange interaction within **SO (3)** group. The inseparable **SU (2)** and **SO (3)** matrixes make inseparable position and momentum. Therefore, the non-separation phenomenon of position and momentum, called uncertainty of quantum mechanics, is the necessary condition to hold discrete invariant translation of symmetries.

The new space and time geometry, which we suggested, is the presentation of new Hilbert space, which is equivalent to Euclidean space where the dimension of a Euclidean-type space may change in accordance with the associated vector space. The **SU (2)** and **U (1)** symmetry groups of standard model do not exist in the same phase, and **U (1)** x **SU (2)** is not the cross products due to the existence of these groups in opposite phases of discrete conservation of energy. Therefore, even the extension of **SU (2) x U (1)** matrixes [2] of standard model to symmetry group **SU (3) x SU (2) x U (1)** [30] cannot describe strong interactions.

For restoration of origin, the eigenvalue of rotation has to have signs ± 1, and model (9) provides this condition. The eigenvector with eigenvalue **+1** describes extension of baryon space–time frame, while **(−1)** in the form of reflection returns the space–time to the origin. Conservation of energy at the origin holds conservation all of the inner products of translation.

The **SU (2)** and **SO (3)** are not subgroups of **U (1)**, as common algebra states; the **SU (2) x SO (3)** and **U (1)** are the products of each other in opposite phases of discrete symmetry. The special orthogonal **SO (3)** rotation symmetry group describes rotation about the origin of the three-dimensional Euclidean space. Orthogonal matrix is the square matrix; a matrix is orthogonal if its transpose is equal to its inverse within equations **Es = 1/2Ea** and **2Es = Ea** which are equal to each other. First is the matrix Q, and second is the inverse matrix.

At **Es = 1/2Ea**, the **SU (2)** symmetry has isomorphic relation to **SO (3)** symmetry, but at **2Es = Ea**, the **SU (2)** symmetry undergoes surjective homomorphism to **SO (3)** symmetry. The surjective homomorphism of the Lie group describes [30] two algebraic structures of the same type, which generates coupling of particle and antiparticle to the same structure. The isomorphism requires symmetry in opposite phases, but Lie algebra does not explain why isomorphic symmetries exist in opposite phases. The surjective homomorphism requires that the ingredients of the homomorphism should have one element, which should be the same for these ingredients. The same ingredient is the mass of particle and antiparticle, which makes them coupling by surjective homomorphism. The particle-antiparticle pair forms a domain-codomain pair where antiparticle codomain is the mathematical image of superposition origin and completely covers the domain function.

At **Ea = 0**, the **SU (2)** matrix gets smooth **2:1** surjective homomorphism to **SO (3)** group matrix which generates **U (1)** symmetry of the background gauge field.

13. Mathematical formulations of SU (2) x SO (3) matrixes

Multiplication of energy-momentum spin relation **Es = 1/2Ea** to **2Es = Ea** eliminates the difference in energy portions, distributed in space and time phases. Using these equations and model (9), we can get the following equations:

$$\frac{\frac{\Delta S}{S_1}}{\frac{\Delta t}{t_1}} = \frac{2\frac{\Delta s}{s_1} - \frac{\Delta t}{t_1}}{\frac{\Delta t}{t_1}} \tag{30}$$

From this formula, we will get:

$$\left(\frac{\Delta S}{S_1}\right)^2 - 2\left(\frac{\Delta t_1}{t_1}\right)\left(\frac{\Delta s_1}{s_1}\right) + \left(\frac{\Delta t}{t_1}\right)^2 = 0 \tag{31}$$

$$\left[\left(\frac{\Delta S}{S_1}\right) - \left(\frac{\Delta t}{t_1}\right)\right]^2 = 0 \tag{32}$$

$$\frac{\Delta S}{S_1} - \frac{\Delta t}{t_1} = 0\ (a),\ \frac{\Delta S}{S_1} - \frac{\Delta t}{t_1} = 0\ (b) \tag{33}$$

The equations (32) and (33) describe the combination of space–time and energy-momentum symmetries in the form **SU (2) x SO (3)** product, which holds conservation of energy within invariant translations.

In mathematics isomorphism is a mapping between two structures of the same type that can be reversed. Model (10) describes isomorphism of SU (2) and SO (3) matrixes not only from the point of view of reverse mapping structures; it shows that due to the reciprocal transformation of space–time and energy-momentum identities, these symmetry groups are not separable from each other.

*The rotational symmetry group **SO (3)** cannot carry translation if the model does not provide the state of origin.* Without initial position of space and time, you cannot build a gauge field theory where the antiparticle cannot find its twin brother in the background gauge field. The energy-momentum exchange eigenvector (12) through angular momentum generates the rotational **SO (3)** symmetry, while the **SU (3)** group of standard model describes only continuous symmetry. The **SO (3)** generates rotation about the origin in Euclidean space. Only this symmetry group with matrix multiplication may produce elementary particles.

The quadratic Eq. (31) with two variables, which is generalized to vector space, is an algebraic expression of quadratic polynomial **P(x, y) = 0** equation. Such a polynomial fundamental equation takes place in conic sectors, having the expression **f(x, y) = 0.**

At **Ea = 0**, the space and time variables became asymptotically equivalent. The asymptotic limit for these variables having binary relation **f (Δs/S1), f (Δt/t1)** can be described as follows:

$$\underset{\frac{\Delta s}{s_1} \to 1}{\text{Lim}} \frac{f\left(\frac{\Delta t}{t_1}\right)}{f\left(\frac{\Delta s}{s1}\right)} = 1 \tag{34}$$

14. Translation of space dimensions. Transmutation of dimension-based physical laws to frequency

We replaced velocity in linear equation of classic electromagnetic field by the frequency to present electromagnetic field, conserved as the cross product of energy-momentum exchange and local gauge field position of space–time. The electromagnetic field **Ea** of model (9) involves electromagnetic fields, and its relation with the magnetic field **Es** produces the three field symmetry **Es = 1/2Ea.**

Model (10) shows that generation of new space vector takes place when dimension of space–time changes. The energy flux, coupled with the space–time (10), determines the space–time structure and dimension of space and time variables. The third dimension of space and generation of mass takes place in discrete mode at positive value of function $\mathbf{Ea} - \mathbf{Es} > \mathbf{0}$.

Based on model (10), the wave amplitude of space–time is the composite product of instant of time and displacement in space, while the wavelength is the composite product of change of time and local space. The time instant $\mathbf{t_1}$ appears as the genetic code of wave amplitude, while the local space $\mathbf{S_1}$ appears as the genetic code of wavelength in the form of superposition.

Conservation of energy in the form of space and time portions requires transmutation of dimension-based physical laws to unit-less dynamics of frequency, which changes through integer numbers (10). While the energy-momentum content of photon is constant, the phenomenon called mass appears as a unit of change of frequency of energy distribution in space–time frame. Change of the frequency leads to the change of the space length and duration of the interaction, keeping the same physical law regardless of scale. At $\mathbf{\Delta S/S1 = 0}$, we get $\mathbf{Ea = Es}$ which shows that when particles move to short or zero distance, the difference between energy and momentum disappears. Thus, mass appears as the space phase equivalent of energy.

To hold conservation of finite amount, energy generates space–time phase through which it moves from one form to another. The **SO (3)** group generates a two-dimensional non-unitary isomorphic space–time symmetry of **SU (2)** matrix which holds the three-dimensional discrete performance of baryon structure through discrete invariant in-out of energy (in the form of so called gluons) to this frame.

Therefore, the discrete in-out external energy (gamma rays, transformed to electromagnetic force) generates additional in-out space dimension in baryon structure of local gauge field. When neutral particles are translated to the background gauge field, the **SO (3)** group eliminates external dimension in baryon structure and returns energy back to vacuum.

Such a performance of **SO (3)** symmetry group is missed in the standard model, and the known symmetry groups of strong interactions do not involve this symmetry. Combination of **SU (2)** non-unitary group with the **SO (3)** matrix generates new principles of fundamental laws which hold invariant translations of all of the natural symmetries through the background gauge field **U (1)**. However, the background gauge field cannot hold its state in continuous symmetry. We may describe the uniform state of a particle in gauge field as $\mathbf{\Delta S/\Delta t = 0}$, which has isomorphism with the matter–antimatter symmetry at conditions where there is no change in space–time:

$$\left(\frac{\mathbf{Ea} - \mathbf{E_s}}{\mathbf{E_s}}\right) = \mathbf{0}, \mathrm{Ea} = \mathbf{Es} \tag{35}$$

Such a state of a particle generates timeless matter–antimatter annihilation, which violates conservation of energy and leads to the ultraviolence divergences. According to the condition (35), it is very difficult to suggest any valid mechanism without renormalization to eliminate ultraviolence divergences with the equal numbers of matter–antimatter.

Wilzcek [17] suggested that instead of number of virtual particles, we have to speak of the numbers of internal loops in Feynman graphs. However, instead of Feynman diagram, we suggest the energy-momentum loop. Wilczek showed that proton mass in Planck unit arises from the basic unit of color coupling strength, which is of order ½ at the Plank scale. We showed that the color coupling code ½ arises from energy-momentum exchange interaction.

15. The new theory of photon

15.1 Dual performance of photons

Quantum mechanics suggests that photons are electrically neutral and do not couple to other photons. Based on our theory, a photon in the background gauge field behaves as color charge "twin pairs" while in the local gauge field became an electrically charged virtual particle-antiparticle pair. In the local gauge field of matter space–time frame, the interaction of photon with the quarks takes place through generation of fractional charge ingredients of photon and their cross coupling with the quark charges which produces Majorana bosons of the background gauge field. Neutrinos in the local gauge field separate colors of gamma photons for generations of quarks for three fractional protons. You cannot see quarks because photon-photon cross coupling eliminates quarks, translating them to the gauge field.

Photon-antiphoton in the form of Majorana particles do not have independent existence and for conservation of energy have to generate the discrete space–time frame of baryon's matter, holding strong interactions. When an electromagnetic field is on, it keeps conservation laws in baryon structure but, when it is off, transforms conservation laws to the background energy phase of gauge field.

Photon in the gauge field is not a single boson, but it is the composite frame of neutral bosons. Invariant translation of fermions to bosons requires cutoff electromagnetic force (**Ea = 0**) where cross coupling of **Es = 1/2 Ea** shape particles to particles of the background gauge field **2Es = Ea** takes place. The color charge mass of photons of the background gauge field appears in the local gauge field in the form of space mass of fractional electric charges of baryon space–time frame.

In accordance with model (9), quanta are the energy-momentum carrying elements, and only the energy-momentum content determines the existence of photons in the form of finite amount of quanta. The portions of energy, carried by space–time portions of energy, appear with the integer numbers (10).

Without clear understanding of half spin phenomenon and the Pauli exclusion principle, we cannot describe photon as a boson. The exclusion principle states that two identical half spin carrying fermions cannot occupy the same quantum state. Pauli's "quantum state" is an abstract point-like state of a particle which does not involve the space–time frame, and his rule does not explain the fact of the existence of two same quarks in baryon's space–time frame. In this sense, Wilczek [16] also raised the question that two identical quark fermions did not appear to obey the normal rules of quantum statistics. It is difficult to understand the pattern of observed baryons using antisymmetric wave functions, as it requires symmetric wave functions.

The formula **Es = 1/2Ea** explains that space and time portions of energy in the form of particle and antiparticle discretely share the space and only half of the available energy belongs to matter's space portion. On this basis, we modified the exclusion principle to the statement that matter fermion with half spin can present only half portion of the available energy in the form of space. With multiplication of fermion space to scalar, we can produce two fermions that can occupy similar space at different times, holding **2Es = Ea** condition. The vector space of matrix **SO (3)** does multiplication of the code **Es = 1/2Ea** by two to produce two quarks, existing in opposite phases with one force carrier quark **2Es = Ea**: decay of proton's **(+2/3)** quark produces in the opposite phase two other **(−1/3)** quarks in the opposite phase. The antiquarks, following the same rule, keep the existence of baryon structure. The Pauli exclusion principle cannot predict such a translation of half spin

fermions to integer spin particles, while the standard model has no cross **SU (2) x SO (3)** matrixes to carry this translation.

In a similar way we can explain why light cannot be at the same time matter and antimatter, which is the necessary condition to carry a finite amount of energy. Distribution of photon energy within space and time phase colors in the space–time frame generates fractional charges in time phase in the form of positron **(+2/3, +2/3, −1/3)** and electron **(−2/3, −2/3, +1/3)** of space phase to hold the genetic code **Es = 1/2Ea**. The quarks appear as the ingredients of photon's fractional charges within the space–time frame which carry a virtual baryon structure and the ingredients of nucleons. You cannot cut and separate fractional charges of entangled quarks into two separate species. That is the reason why the ingredients of quark-antiquark pair do not have independent existence, which is specified as *the confinement problem of quantum physics*.

Quarks in the proton-neutron frame exist in the form of fractional charges; that is why we cannot see a fractional proton or fractional neutron, but we can see a pion, which appears from doubling of photon's fractional charges. This mechanism explains the phenomenon that when the quarks of nucleon are poked by high-energy photons, the quarks show behavior as they were free particles [17]. Cross coupling of photon's quark ingredients with the second photon leads to the scaling of the genetic code **Es = 1/2 Ea** to **2Es = Ea** which generates free neutral particles. The cross coupling of fractional charges of a photon in baryon frame through **SO (3)** matrix leads to the formation of a pion—the lightest particle to produce the background gauge field boson which plays a role of a Goldstone boson. In the local gauge field, the photons, as neutrinos, became Dirac particles, while in the background gauge field, they are Majorana pairs.

The condition **Es = 1/2Ea** is the threshold energy to hold a photon within fractional electric charges of baryon frame. Photon seems to be not a fundamental unit and conserved in space–time in the form of fractional quark unit. In such a mechanism, the threshold energy is not the bound energy of electron in metal, but it is the energy required to hold **2Es = Ea** transformation of fractional electric charges which is necessary to produce integer charges**.** The integer electric charge is the combination of fractional charges, produced by coupling of condition **Es = 1/2Ea**:

$$\mathbf{1} = \mathbf{3/3} = (\mathbf{2/3}) + (\mathbf{2/3}) - (\mathbf{1/3});\ -\mathbf{1} = -\mathbf{3/3} = (-\mathbf{2/3}) + (-\mathbf{2/3}) - (+\mathbf{1/3}) \tag{36}$$

That is why photoemission is not a one-step process, described by Einstein's linear equation, which does not cover these steps. Generation of integer electrons depends on the energy-momentum genetic code (**Ea/Es**−**1**), which determines a threefold frequency.

Model (10) suggests that Planck's emission of photons takes place only through merging of fractional charges. At **ΔS = Δt**, we can get the equation for photon radiation:

$$\frac{\mathbf{E_s}}{\mathbf{E_a}} = \frac{\frac{\mathbf{S1}}{\mathbf{t_1}}}{\frac{\mathbf{s1}}{\mathbf{t_1}} - \mathbf{1}} \tag{37}$$

Radiation takes place uniformly through the reduction of frequency by integer numbers, which describe numbers of energy portions in relation to total energy. The **Ea** in Eq. (37) presents the total numbers of elementary quanta. At Planck scale with the uniform distribution of energy in space and time phase, using condition (37), we can get the Planck formulation **Es = hν** where **h** presents the vacuum expectation value of background energy **(Ea).**

15.2 The three fractional proton families of baryon frame

Presently there is no quantum field theory, which may include space–time as the main ingredient of strong interactions. By Weinberg's opinion [1], isospin conservation, which governs strong interactions, has nothing to do with space and time. However, without space–time, it is impossible to produce the theory of strong interactions because space–time is the matrix for flux of energy to baryon frame. Discrete conservation of energy, carried in the space–time by minimum elementary grain of space–time frame of matter (baryon frame), is the same phenomenon called strong nuclear interactions. The strong interactions arise from conservation of energy within the space–time, which has to hold basic elementary baryon's space–time unit.

If displacement in the space–time frame of baryon frame has a trend for contraction (**ΔS = 0**), the space–time frame of baryon frame disappears, and the ingredients of baryon structure became free particles (**Ea = Es)** which appear as the "asymptotic freedom phenomenon" of gauge field. By quantum physics, energy is borrowed for the generation of particles-antiparticles, but the energy, borrowed from the background gauge field, in reality is required for discrete performance of baryon's frame. According to our theory, the integer proton-neutron pair may exist only within three fractional families, with involvement of other quark flavors, existing through internal color charge interactions between them with untouched spin relations. The condition **2Es = Ea** produces all types of symmetry (**n, ι, $m_ι$**) within three fractional proton-neutron families, but the ingredients of this symmetry have a difference only in color mass (**m_s**). The proton mass does not come from quarks, but it is comprised of the energy which keeps invariant interactions of three fractional proton-neutron families. To hold color-based interactions between quark flavors of fractional protons, quarks have different colors.

Quantum mechanics suggests that isospin, which identifies proton and neutron as the different states of same particle due to the small mass difference, is an approximate symmetry. In accordance with our theory, the extra mass of neutron in comparison with proton arises from coupling of proton-antiproton pairs, which adds mass of color interactions within fractional charges. On this basis, proton and neutron are not the different states of the same particle. The neutron-antineutron pair is the different state of proton-antiproton pair.

According to the Yang-Mills theory [20], when electromagnetic interaction is neglected, the isotopic spin has no physical significance, and all physical processes would be invariant under isotopic gauge transformations. It was shown that when electromagnetic field is not involved, all interactions are invariances at all space–time points. But these statements could be true only partly because when electromagnetic field is not involved (**Ea = 0**), all transformations move to the background gauge field where space–time forms the frame of integer spin carrying particles.

In accordance with the **SO (3)** symmetry, the local **Es = 1/2Ea** and the background gauge field **2Es = Ea** require existence of **uud –ddu** proton-neutron relation within two rotations**.** Such an existence of quarks determines similar existence of other two fractional proton-neutron families, which occupy top-down location of **uud-udd** in an alternative mode. In this case, the color charges of quarks cancel each other. This principle explains problems, raised by Wilczek [16] who showed that it is difficult to get quark-antiquark color cancelation which needs energy. In accordance with our theory, rotation of fractional proton families' realizes charge cancelation during locating them alternatively at top-down positions.

The ingredients of background gauge field appear in the form of dark matter/dark energy, the composition of which is the same as dark energy/dark matter

composition of universe. The portion of every boson in gauge field is 33%, which explains the predicted dark matter composition.

15.3 What is the Planck scale? Where did it come from?

It is well known that the Plank scale is the magnitude of space, time, and energy below which the prediction of quantum theories is no longer valid and quantum effects of gravity are expected to dominate. Planck units are derived by normalization of the numerical values of certain fundamental constants to 1: $\mathbf{c} = \hbar = h = \mathbf{\mathcal{E}o} = \mathbf{k} = \mathbf{1}$.

Planck did normalization of different constants regardless of their dimensions. However, as we showed through the example of energy-mass transformation of SR, such a normalization can be done if physical quantities were expressed with dimensionless units, which give numbers. The relation of changes to their initial value, which we applied, gives proper normalization, which is a dimensionless non-unitary operator. Model (9) describes the Planck scale as the boundary position of a particle in space–time where the change of space presents wavelength, while amplitude is the initial space locality. The conditions of model (9) $\mathbf{\Delta S = S1, \Delta t = t_1}$ are the boundary condition for existence of the space–time which may present the Planck space and time. Model (9) describes normalization of all the dimensionless parameters to 1. The space–time triangle wave with the equal wavelength and amplitude is the Planck scale of space–time. When $\mathbf{\Delta S < S_1}$, there is the no space–time frame and strong interactions of baryon frame. This is the phenomenon called vanishing of the effective coupling at short distances.

At high-energy region, close to $\mathbf{\Delta S = 0}$, there is no consumption of energy for displacement of space which presents quarks as a point-like particle. The point-like interaction out of space–time "is equivalent to no interaction," because at point-like particles, there is no conservation of energy and there is no particle. In the similar way light cannot be identified as a point-like particle because light without emission from the space–time frame cannot exist. Without space–time with local position, energy is not conserved, and baryon structure does not exist. Therefore, without mathematics of space–time frame, we cannot explain strong interactions and "asymptotic freedom of baryon quarks at short distances."

When the local momentum merges with the initial momentum, the local position also merges with the initial position. Therefore, due to the non-separable conservation of energy-momentum in the space–time frame, momentum and position are not separable identities. The time-energy relation of the uncertainty principle involves interval of external time, which flow independently of measurement. However, in the concept of production of space–time position from energy conservation, the outcomes of the uncertainty principle probably will be different. The condition $\mathbf{Es \geq 1/2Ea}$ of the model describes the limit above which **Ea** may present the Planck scale, where the space–time and local position do not exist.

Following to the genetic code $\mathbf{Es = 1/2Ea}$, existence of position and momentum in different phases generates non-commutation of these identities.

16. Gluons

The standard model does not provide any information on gluon's origin. Based on our theory, only the origin of a particle can give information on how it will behave. This is the requirement of the causality that "past determines future."

Invariant translation from the local gauge field to the background field shows that gamma rays are the products of transformation of electromagnetic energy

during decay of the space–time phase of baryon frame and within $2E_s = E_a$ invariance translation became vector boson of the background gauge field. The **e/e** and **ν/ν** pairs, produced simultaneously, do not have independent existence, and with gamma rays they form three-jet particles to hold $2E_s = E_a$ symmetry of the background gauge field.

When the flux of electromagnetic interactions to baryon structure is neglected **(Ea = 0)**, electrically charged interactions disappear, but color interactions without change are translated to the background gauge field. The color interactions in baryonic frame do not touch spin interactions of baryonic quarks but hold interactions within three fractional proton-neutron families. Therefore, the color of light photon as a variable is needed to generate translations between electrically charged spin **Es = 1/2 Ea** and color **2Es = Ea** interactions.

The color charge of quarks is required to carry interaction between fractional protons. The correct mass of proton can be calculated only from color-based interactions within fractional protons, and the theories based on a common proton-electron structure cannot produce correct proton mass. The interaction between fractional protons is spin invariant and determined by the color interactions. The six of eight gluons participate within the three fractional proton-neutron families, two between proton-antiproton-neutron-anti-neutron interactions.

The ingredients of exchange interaction in baryon's space–time frame carry three symmetric interactions. The first is the symmetric energy-momentum interaction, regulated by conservation of spin numbers **(Es = 1/2Ea)**, which takes place between quarks. The second symmetric interactions take place internally within ingredients of baryon frame, (a) the internal color-based symmetric flavor interactions within quarks (called gluons color charge interactions), which combine two symmetric internal interactions **a = b1+ b2**: (a1) the internal mass-based symmetric interactions within neutrinos and (b2) the internal mass-based symmetric interactions within electron families.

At **Ea = 0** takes place invariant translation of color- and mass-based internal symmetric interactions to the background gauge field to hold the symmetric internal interactions within neutral electron and neutrino families. In reverse translation of energy conservation from background energy phase to local space–time phase, the color charge transforms to electric charges of quark-antiquark families. The energy inserted to quark families of baryon frame is the gluon of gamma photons from the gauge energy phase. Due to the discrete insertion of gamma photons to quark frame of baryon structure, the mass of individual quarks is very less than the proton-neutron masses.

17. New principles of quantum chromodynamics theory

The QCD theory is a non-Abelian gauge theory (Yang-Mills theory) and based on approximate **SU (3)** symmetry. Gell-Mann suggested [31] that quarks do not have space–time frame. Such an approach was the main reason for the appearance of approximate SU (3) symmetry because point-like behavior of quarks cannot carry conservation of energy. The other problem of the Gell-Mann approach was due to the application of Lagrangian continuous field, which produces approximation for perturbative theories. In addition, the theory used nonsymmetric four-momentum frame of special relativity. In accordance with our theory, without the discrete space–time symmetry, all field theories will produce approximate symmetry.

Our theory shows that quarks are not Gell-Mann's mathematical construct; they are ingredients of photon's fractional charges, distributed within the space–time frame of baryon frame. Han [32] desired to construct models in which the quarks had integer value electric charges but was not able to deliver a theory.

The other problem of the field theories is that, as Gross [28] perfectly suggested, quantum field theories do not know which field to use and cannot explain why all the hadrons, baryons, and mesons appeared to be equally fundamental. The field theories do not clarify properly the nature of gauge field and unify the four forces for description of fundamental interactions.

Model (10) combines all fundamental interactions within only electromagnetic and gravitation forces, strength of which changes with the integer numbers. The background gauge symmetry is the vacuum, which has no independent existence; that is why it mediates local gauge field. Such features of the background gauge field eliminate renormalization procedure, which is widely applied in quantum field theories. At maximum boundary energy (vacuum expectation value **Ea**), energy does not runaway to ultraviolent divergence due to translation of energy for separation of space **e/e** and time **ν/ν** spin one neutral pairs. In this case, separation of **U (1)** matrix into two symmetries takes place with the generation of space–time **SU (2)** and energy-momentum **SO (3)** matrixes. It is reduction from **2Es = Ea** background symmetry to the local gauge field symmetry **Es = 1/2 Ea** with generations of ½ spin carrying fermions and integer spin carrying photons of electromagnetic force. This invariance translation generates electromagnetic force with the positive sign **(Ea−Es)/Es.**

QCD is based partly on Poincare symmetry [33] that involves: (a) Abelian Lie group, (b) rotation in space to the non-Abelian Lie group, and (c) transformations connecting two uniformly moving bodies. However, having the excellent statements of (a) and (b), Poincare symmetry is not free from the problems due to the application of Minkowski's four-momentum space–time isometries that produces a semi-direct product of the translations. However, the statement (c) does not hold conservation of energy because it ignores boundary of motion.

The Wikipedia discussion [33] on Poincare symmetry shows that it might be possible to extend the Poincare algebra to produce super-Poincare algebra that may lead to the supersymmetry between spatial and fermionic directions. However, Poincare symmetry due to the absence of initial position cannot deliver conservation of energy at origin.

Nambu [34] suggested that the nucleon mass arises largely as self-energy of some primary fermion field, similar to the appearance of energy gap in the theory of superconductivity. According to his opinion, the nucleon mass is a manifestation of some unknown primary interaction between originally massless fermions. In addition, the pion is not the primary agent of strong interactions, and the nature of primary interaction is not clear.

In accordance with our theory, Nambu's coupling is the discrete cutoff electromagnetic energy **(Ea = 0)** to baryon space–time frame, turning fermions to bosons of the background gauge field, which performs as the superconductive medium due to the absence of fermionic space–time frame of "free" boson particles of condensate.

Our theory explains the ratio of spin constituents on the basis of ratio of transference σ_T and longitudinal waves σ_l of virtual photon ($R = \sigma_T/\sigma_l$) discussed by Gross [28]. At **Es = 1/2Ea** we get transference waves $\sigma_l = 0$, while at **2Es = Ea** it transforms to longitudinal wave of virtual bosons $\sigma_T = 0$. If the constituent has spin zero, the σ_T became zero $\sigma_T = 0$, but if spin is ½ the σ_l became zero.

18. The triplet model of hadron particles and problems of quantum mechanics

It is necessary to note that the three particles performance of nucleons was the mystery of strong interactions.

Heisenberg [35] suggested that the proton and neutron are different states of the same particle, which should produce integer spin for the nucleon because of the addition of the angular momentum of the constituents. He called this rule addition law and suggested that full spin of the nucleon is always integer if the mass number is even; the full spin is half-integer if the mass number is odd.

Sakata suggested [36] that the even-odd rule and addition law can be applied for other particles as well. He suggested the model of hadrons, which comprised triplet of proton, neutron, and lambda, but later the quark model was suggested where triplet of **uds** quarks replaced **pnλ**. Sakata's model could not explain why hadrons should follow triplet performance of particles, and Sakata suggested that three **pnλ** particles are composite states of some hypothetical object called B matter.

The mystery of triplet particles generated significant concern for particle physics theories when in 1964 unusual decay spectrum of kaon was reported [37]. Decay of neutral kaon produced mixture of $\boldsymbol{\pi - \pi + \gamma}$, which by the author's opinion "no physical process would accomplish this decay and any alternative explanation of the effect requires highly nonphysical behavior of three body decay of neutral kaon." The author suggested that the presence of two-pion mode implies that the neutral kaon meson is not pure eigenstate. Such a decay process leads to the new direction of studies of particle physics, called spontaneous symmetry breaking.

The eigenvalue (12) of model (9) shows that the triplet performance of hadron holds condition 2**Es** = **Ea** and has pure eigenstate to hold symmetry. This eigenstate requires existence of symmetry of integer-half-integer particles with the condition $\boldsymbol{\pi - \pi + \gamma}$, which meets the requirement of eigenstate (12). Therefore, there is no symmetry breaking in kaon decay to $\boldsymbol{\pi - \pi + \gamma}$, and the force called weak interaction is the gravitation force which holds the existence of the nucleon in discrete symmetry within **Es** = **1/2Ea** and **2Es** = **Ea** invariant energy translations.

Translation of local gauge symmetry **Es** = **1/2Ea** to background symmetry **2Es** = **Ea**, due to the existence of quark flavors in three families of fractional protons, requires counterpart mixing of quark flavors with generation of kaons. Flavor mixing appears through mixing of **SU (2)** and **SO (3)** matrixes. *Due to the existence of three fractional proton-neutron pairs, the formation of three kaons is the necessary condition to hold discrete symmetry.*

Kobayashi [38] showed that CP violation would occur if irreducible complex number appears in the element of mixing. By terminology, the irreducible polynomial has a meaning that it cannot be factored into the product of two nonconstant polynomials. The symmetric reduction of condition 2**Es** = **Ea** to **Es** = **1/2Ea** meets this requirement. The other condition for CP violation, as Kobayashi mentioned, is that the complex number remains in the polynomial equation, which cannot be removed by the phase adjoint of the particle state. The polynomial Eq. (32), describing mixing of **SU (2) x SO (3)** matrixes meets this requirement as well. By Kobayashi's opinion, flavor mixing arises between gauge symmetry and particle states. Kobayashi's statement is partly equivalent to our approach only while flavor mixing is the requirement of invariant translation within the background local gauge fields.

The standard model suggests that the CP violation is due to the essential difference between particles and antiparticles. Based on our theory, particles and antiparticles exist in different phases and are connected through symmetry mediator electromagnetic energy; when it is off, the antiparticle as the displacement merges with its superposition twin particle.

Formation of integer spin within proton-neutron pair in the nucleon through the addition law of proton and neutron is not possible because the proton and neutron do not exist in the same phase. The integer spin at an even mass number is described

by symmetry **2Es = Ea**, while half spin at an odd mass number is expressed by the condition **Es = 1/2Ea.**

Transformation from kaons to bosons of gauge field involves the following steps: coupling of fractional proton-antiproton pairs to kaon → coupling to neutral kaon → decay to pions → coupling to neutral pions → decay of neutral pions to quark ingredients with participation of intermediate W bosons through discrete translation of **Es = 1/2Ea** and **2Es = Ea** symmetries to each other**.**

19. The principles of isospin symmetry

Kibble [29] showed that the proton and neutron are not identical which the reason for generation of approximate symmetry. The proton has an electric charge, but the neutron does not. On this basis, the isospin symmetry, which describes proton-neutron symmetry by **SU (2)** group, was accepted as an approximate symmetry.

The standard model suggests that while isospin is an approximate symmetry, it must be broken in some way [29]. However, the addition of symmetry breaking terms generates non-renormalizable theories, producing infinite results. Therefore, the reason why the symmetry must be broken remained a mystery of particle physics. On this basis, the standard model, avoiding the need to add explicit symmetry breaking terms, suggested spontaneous symmetry breaking [29]. However, the spontaneous symmetry breaking theory of the standard model, producing massive bosons, did not explain the main problem of isospin that generates asymmetry: why the neutron has more mass than the proton or the proton has less mass than the neutron.

In accordance with quantum mechanics, the physical situation is unchanged if the electron wave function is multiplied by a phase factor [29]. This transformation involves a constant (α) and an imaginary number. The problem of such a transformation is that the constant (α) describes space–time in exponential function without involvement of space–time variables and their boundary. The other problem of this transformation is that if the electron wave function is multiplied by the phase factor, the physical situation changes and produces different phase symmetries.

In Kibble's analysis there is one excellent statement that spontaneous symmetry breaking occurs when ground state or vacuum does not share the underlying symmetry of the theory. As we showed, the background gauge symmetry does not exist independently and exists only in conjugation with the local gauge field, which appears as invariant translation of energy from the background vacuum.

Therefore, the isospin symmetry is not related to proton-neutron translation. As we showed in this chapter, isospin between the neutron and proton exist within the translation of proton-antiproton pair to neutron-antineutron pair with rotation of local gauge field to the background gauge field. The $\mathbf{\Delta S/S_1}$ and $\mathbf{\Delta t/t_1}$ operators of model (9) within **2 x 2** non-unitary matrix have the exact **SU (2)** symmetry and carry this translation. This symmetry within the **Es = 1/2Ea** genetic code of the energy-momentum isospin symmetry generates a supersymmetry within the three particles' performance of baryon frame which exist in discrete mode in conjugation with the background vacuum.

20. Conclusion

We developed a new supersymmetric gauge field theory of photon, which describes fundamental laws of physics through invariant translation of discrete

symmetries of nature. Simply, we developed a new gauge theory of photon, which describes all the fundamental laws through conjugation of the discrete space–time **SU (2)** frame and energy-momentum **SO (3)** symmetry group. At background gauge supersymmetry **Ea = 2Es**, all the forces and interactions are symmetrically entangled. Based on the theory, *gravitation appears as the short-range force, which holds discrete performance of electromagnetic field for the existence of the nucleon in discrete mode*. Nature outlined this rule to avoid approximate symmetry in its fundamental laws.

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